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ABSTRACT

The challenges of today lead to more technology rather than less for our culture in the future. Ability to process information symbolically in language and numbers will become increasingly important for employment and for participation in our culture. The fact that plasticity in psychological development is greatest during infancy and early childhood guarantees, in the long run, an important place for early education in the adaptive evolution of our society. Although many problems in the domain of early psychological development remain unsolved, they can be studied if the necessary research is supported. Then, the technology of education for infants and young children can be improved enough to enable all but a very few to take a productive place in our increasingly technological culture. (Author/ED)

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THE PROSPECTS OF EARLY EDUCATION IN SOCIAL EVOLUTION

by J. McVicker Hunt

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Societies, like individuals, appear to have mood swings. The pendula of collective opinions appear to swing back and forth between polar extremes. Thus, the technology of power production, coordinated with the great achievements in the physical sciences, brought about the industrial revolution. As this revolution essentially eliminated the scarcity of material goods for human consumption, it gave rise to a mood of optimism and to a sense of power bordering on omnipotence. The revolution also gave rise to the business cycle with its alternations of depression and pessimism with prosperity and optimism.

This past decade has brought collective appreciation of impending problems in a variety of areas: power shortage, overpopulation, ecological damange to spaceship Earth, and the problems of poverty. With this appreciation has come a collective mood of pessimism about man's place in the world and the pendula of collective opinions appear to have swung simultaneously toward antimaterialism, toward the irrational and anti-scientific, and toward a simplified world with less technology. If science and technology have let us down, it is often argued now, drop science and technology, use a minimum of material goods, and look to states of consciousness induced by drugs and meditation to make life bearable if not interesting.

Our collective appreciation of man's problems on spaceship Earth are well taken. Man's social institutions are, indeed, in for some adaptive modifications. While the industrial revolution solved some problems, it made others. It provided the capacity to make more things than people could buy with the purchasing power made available to them through wages. The resulting business cycle produced the problems of modern economics and social organization with which we are still endeavoring to cope. This revolution separated the workers from their tools and crowded them around the factories in slums that gave rise to the squalor described by Jacob Riis. More directly germane to my topic, the industrial revolution almost destroyed the family as an educational institution. No longer could children acquire the skills for their livelihood as apprentices to their parents. In consequence of these processes, the neighborhood peer group emerged and became, willy-nilly, a major educational institution.

A substantial share of our current problems derive from the recent wave of migration from the farms of America to the cities. This migration stems from the industrial revolution in agriculture. Such mechanical inventions as the cotton picker, the sugar-beet topper, and the automated feed-lots for cattle and hogs have greatly reduced the demand for unskilled labor on the farms. Where about 60% of our population lived on farms in 1920, less than 10% live there today. At the same time, our burgeoning technology is demanding for its management people with highly educated symbolic skills. These are serious problems. Adaptive modifications in our social institutions and in our mode of life must come.

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Our society, indeed western civilization, faces a variety of perplexing problems. But, as John Gardner is fond of saying, "Difficult problems provide great opportunities." This opportunity does not lead back to the simple life, unless we destroy our civilization in an atomic holocaust that forces mankind to start over. I am fairly confident that we will gradually evolve solutions to our problems and make the necessary changes in our social institutions. Moreover, we will do it with more science and more technology directed toward the challenges of our day. While education in general, and early childhood ecucation in particular, can be only a part of the solution process, it is an important part. Child-rearing and education adequate for a social economy providing a large demand for unskilled labor cannot develop citizens with the competence, motivation, and values required to cope with the problems looming in our immediate future. The behavioral sciences must help to bring forth appropriate innovations in the technology of education required to produce citizens competent to cope with these problems mankind has made for himself. If democratic societies are to survive, the technology of education must provide experiences for the young from infancy on through youth that will encourage higher levels of intellectual competence, social motivation, and ethical concern than we have ever known.

A DECADE OF EARLY EDUCATION

We are now emerging from a decade of experimenting with early childhood education. It started as a part of the Kennedy-Johnson War on Poverty. Three kinds of considerations appear to have participated in the launching of this experiment. One was the obvious needs of children in poverty. These needs had long been evident, but they got a new dramatization in Michael Harrington's (1962) book entitled, "The Other America." Children of families of poverty had long been observed to fare badly in school. The second factor was a belief that it would be reasonable to hope that something educational could be done about the scholastic failure of poor children. It came from the evidences of plasticity in psychological development (see Hunt, 1961). Third, these evidences of plasticity had ethical implications. They implied that the fate of the children born by accident to families of poverty was in considerable part a matter of nurture. This combination of considerations produced a challenge with ethical compulsion behind it.

A bit of history will explain why this ethical compulsion failed to appear earlier. In the 19th century, Darwin's survival theory of evolution got interpreted, especially by Herbert Spencer, Francis Galton, and William Graham Sumner, to imply that the characteristics of individuals and their development are essentially predetermined by heredity. The intelligence-testing movement derived from the anthropometric laboratory of Francis Galton, in England, and from the work of Alfred Binet and his collaborators, in France. Even though Binet's tests were constructed in order to help the poor learners to do better in the Paris schools, it was the view of Galton that prevailed. The mental age of Binet and Simon and the IQ of Wilhelm Stern came to be viewed as essentially fixed dimensions of individuals predetermined by their heredity. It was out of this belief that we got the claim of the constancy of the IQ. During the 1920s and 1930s, evidences of plasticity in early development emerged here and there, but the collective faiths of predetermined development and fixed intelligence were so strong that these evidences were either denounced or explained away (see Hunt, 1961, Chaps. 2 & 3). I recall well the derision which met the evidences of plasticity

associated with the transfer of infants from an orphanage to a ward for young women in an institution for the mentally retarded, as reported by Skeels and Dye (1939). Anyone who entertained the idea of increasing the "natural competence" of human beings was put off as a soft-headed "do-gooder." So long as the collective faith in intelligence fixed by heredity prevailed, the ethic of equal opportunity had no force toward special educational opportunities for children of the poor.

Evidences of developmental plasticity, however, continued to accumulate. The theorizing of Donald Hebb (1949) inspired a variety of investigations indicating that the problem-solving ability of animals vary substantially with the nature of their early experience. Those reared as pets or with an opportunity to look at various kinds of patterns proved to be better solvers of maze problems as adults than their litter-mates reared in opaque laboratory cages. Moreover, Thompson and Heron (1954) found the degree of superiority in the problem-solving ability of pet-reared Scottie dogs over their cage-reared litter-mates to be, if anything, more pronounced than the degree of superiority that Hebb (1947) had found for pet-reared rats over their cage-reared litter-mates. The evidence at least suggests that the importance of early experience for later competence increases up the evolutionary scale (Hunt, 1961, p. 315ff).

Other lines of investigation suggested other generalizations. Early environmental encounters giving rise to a wide variety of sensorimotor experiences appears to influence not only the development of behavioral competence, but of neuroanatomical maturation as well (see Hunt, 1969, Pp. 194-195). Investigations of various kinds yielded evidence that the longer organisms live under any given kind of circumstances, whether they foster or hamper development, the harder it is to alter the influence of those circumstances on either behavior or neuroanatomy (Hunt, 1961, p. 321ff; 1969, p. 15ff). For those believing that the effects of heredity are several times as large as those from the life history, the fact that 60% of each new generation comes from the bottom third of the population in socio-economic-educational status with a mean IQ of about 85 has been a worry. From these facts, Cattell (1937) estimated that the IQ could be expected to drop a little over three points each generation, or about one point each decade. The actual changes that have been found, however, have been increases rather than decreases. Moreover, these increases have been of the order of ten points for the decade associated with the social changes instituted by the Tennessee Valley Authority (Wheeler, 1942), between 10 and 15 points for the samples of Minnesota high schools, tested first in the 1920s and again in the 1940s by Frank Finch (1946) and 20 points for the mean IQs of children in a sample of schools in Honolulu first tested in 1924 and again in 1938 by Smith (1940). It is such evidence that made it reasonable to hope that a large-scale experiment like Project Head Start might succeed in accomplishing something.

Justifiable hopes were exaggerated, however, by that swing of collective opinion toward egalitarianism that was part of the climate which produced the Supreme Court decision of 1954 that racially segregated schools could not provide equal opportunity. Many came to expect that a summer or a year of nursery-schooling could compensate the children of the poor for all they had failed to learn in their homes and thereby prepare them to hold their own among children of the middle and upper classes in schools. Many of us most concerned with investigations of the effects of early experience and most convinced of the plasticity in

early psychological development were fearful that the hopes for Project Head Start were being set unrealistically high. Although we had some educated guesses, we knew that a tested educational psychology for infancy and early childhood was lacking. I should say in passing, that some of my own guesses, such as the idea that the variety of experiences one would associate with crowding of families of poverty might prove advantageous in infancy, proved to be very wrong (Hunt, 1962; Wachs, Uzgiris, & Hunt, 1971). Although many of us most concerned with early experience hoped we were wrong, the idea of overcoming the effects of four years of experience poorly calculated to foster psychological development sufficiently to enable children of the poor to become competent enough to get along successfully in the public schools seemed highly unlikely. When the surveys of the United States Commission on Civil Rights (1967) and of the Westinghouse Learning Corporation (Cicarelli, 1969) confirmed this expectation, it was disappointing, but hardly surprising.

The awesome size of Project Head Start greatly increased the concern of academic investigators with the characteristics of class differences in intellectual competence and motivation and focused attention on what is and is not learned in their homes by preschool children. Reviews of the already-existing literature brought out that children of poverty are typically acquainted with a less complex variety of objects, places, and persons that children of middle-class backgrounds. New studies brought out that children of poverty fall substantially below the norms for tests of recognition vocabulary, vocabulary of use, length of remarks, and complexity of sentence forms. Part of such cognitive-linguistic deficiencies may result from lack of even the basic requirements for biological well being and growth. More than likely a larger share derives from the fact that parents in families of poverty typically spend less time in verbal interaction with their children than do parents of the middle-class. Even while communicating with their children, these parents of poverty verbalize in sequences substantially shorter than those of parents from middle-class background. Moreover, when children of the poor ask questions or talk up, their parents are all too likely to respond with "Shut up" without even saying why. Middle-class parents also tell their children to "Shut up" but they typically follow this command with such explanations as: "Can't you see I'm on the telephone?" or "Can't you see that I'm busy getting dinner?" The difference is substantial. Moreover, living in crowded circumstances where the objects of communication are visible to all permits pointing and obviates the necessity of developing collective vocal signs for communication about them. The result, as might be expected, is the limited linguistic code of the poor so well described by Basil Bernstein (for sources, see Hunt, 1969, pp. 202-208).

Such investigations also turned up motivational deficiencies. Since there is seldom enough of anything available in a family of poverty and little hope that there will ever be enough of anything in the future, children get reinforced for taking all that they can get while they can get it. Oscar Lewis has given dramatic accounts of these conditions in his descriptions of the culture of poverty. It is not surprising, therefore, that children of the poor learn laboratory tasks better for concrete rewards, while children of middle class families work harder for the reinforcement of social approval. Similarly, children of poverty prefer immediate reinforcement over delayed reinforcement even when the rewards to be obtained with delay are obviously larger than those to be obtained immediately; the opposite is true for children of middle-class and upper-class backgrounds.

Under these conditions of poverty, children can hardly be expected to develop the persistence of effort toward the completion of tasks once started, a sense of inner control, and a feeling of responsibility for what happens to one. Thus, it is not surprising that Battle and Rotter have found considerably less evidence of the feeling of responsibility for what happens in children of the poor than in children of middle-class background. Similarly, since concern for the future has little chance to develop, it is not surprising that LeShan has found the children of poverty more concerned with matters in the present and less concerned with those of the future than children of middle-class background. (For sources, see Hunt, 1969, pp. 208-214).

This accumulation of evidence concerned with the nature of the developmental deficiencies in children of poverty combined with the beginnings of evidence concerning why those deficiencies would be expected demonstrated that the kinds of nursery-schooling deployed in a major share of the Head Start programs was very poorly calculated to compensate children of poverty for what they had missed in their first four, or even three years. Although Maria Montessori in Italy, and Margaret McMillan in England, originally devised their nursery-schools for children from families of poverty with the idea of helping them learn what they had missed in their homes, when nursery-schools were transferred to the United States, only the well-to-do could afford them. The curricula were then adapted to what were considered to be the needs of children from well-to-do families. Play-schools were the result. The aim was to give children of over-controlling mothers a few hours of free play for some five half-days a week. Although there was actually considerable variation in the nursery-school programs utilized in Project Head Start, playschool programs were the most widely deployed. Even though children of poverty deserve an opportunity for such play, it would have been hard to chose curricula more poorly designed for the compensatory educational purposes upon which the hopes for Head Start were based. Failure to fulfill the unrealistic hopes held for it was almost guaranteed by the kind of nursery-schooling deployed.

A number of students of early childhood gleaned the outlines of this picture almost as soon as Project Head Start was launched. Well before the disappointing results from the evaluations of the Project had appeared, a number of university-based innovators in early childhood education had devised programs designed to teach children of poverty what they had had no opportunity to learn at home. Many of these were teacher-centered approaches with curricula focused on teaching skills that the innovators conceived to be important for children entering school. Among the earliest of these were Susan Gray and R. A. Klaus at George Peabody College for Teachers in Nashville, Tennessee, and Martin Deutsch and his collaborators at New York University. For these innovators, the curriculum aimed at interesting children in matters scholastic and inculcating a motivational concern for achievement. Gray and Klaus, however, also innovated the involvement of mothers and the home in early educational process. Early in the game, Bereiter and Engelmann of the University of Illinois devised the no-nonsense curriculum focused on teaching children the kinds of skills on which normal and superior performance on standard, norm-referenced tests is based. They emphasized especially speaking clearly with standard syntax and the number concepts. They sometimes referred to their approach as the "pressure-cooker." David Weikart and his collaborators in Ypsilanti, Michigan, developed a highly structured preschool program based upon the developmental theory of Piaget. In these and others of the pioneering teacher-centered programs, the child-teacher ratio was usually five to one. Compensatory education is expensive.

Other innovative programs were more like the early innovations of Montessori in that the teacher was taken out of the center and given the task of preparing situations that would get the children to learn through doing. At the University of Arizona, in Tuscon, Marie Hughes incorporated a highly structured curriculum in games and projects in which her Mexican-American children had a ready-made interest. Although the law required her to deal with first-grade classes of 30, these large classes were broken down into sub-groups of about six for planning and executing the projects. One highly ingeniously aspect of the Hughes program aimed simultaneously at teaching the children both English and a concern for the future. The technique consisted in having the small groups of children choose and plan a project with the discussion in English, revise and replan the project on another day, execute it on a later day, and tell the story of the execution on the day following it. The stories were tape recorded. After they had been transcribed, the children had a day or two at a listening post where each heard his own story and that of each of the other five in his group while each watched and read the transcripts in poster type. At Northern Colorado University in Greeley, Nimnicht, Meyer, and McAfee developed in their New Nursery School a materials-centered program with a responsive environment where only the teacher herself initiated interaction with children, where all aides responded to requests from the children with the help requested, and where the materials were arranged to invite learning.

All of these programs showed considerable success. Children typically gained considerably more than a year of mental age on standardized tests of intelligence and achievement. The largest gains in four-year-olds were reported by Bereiter and Englemann where the external pressure to learn was strong and the curriculum was directly focused on the kinds of understandings and skills that the tests test and that the schools require. An evaluative comparison of three of these preschool programs by Merle Karnes and her collaborators at Illinois considered both the gains made while the compensatory education was in operation and the persistence of these gains into the regular school program. During the compensatory program, the gains in IQ from the Bereiter-Englemann program were the largest -- approximating 23 points. Although these children in their program lost more during their first grade in the public school than did children from the other programs, they remained nearly ten points ahead of the others at the end of the first grade. This tendency for the gains to wash out with time prompted the White House committee that I chaired for President Johnson in the fall of 1966 to recommend an extension of Head Start up the age range in the Follow-Through Program for which results are only now beginning to be reported. Weikart's program produced larger gains in three-year-olds than in four-year-olds. This finding combined with the evidences of diffusion from target children whose mothers were involved in the teaching to the children of neighbors prompted this task force to recommend also an extension down the age scale in the Parent and Child Centers.

Thus, the great social experiment of Head Start was launched with hopes unrealistically high and without an adequate educational technology. While it has failed to achieve those unrealistic hopes for it, it has inspired investigation yielding a quantum gain in information about the deficiencies of children of poverty and about the rearing conditions from which these deficiencies derive.

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It has also motivated substantial improvements in technology of compensatory education and in the possibility of effective programs for teaching many of the parents of poverty how to improve the educational aspects of their relationships with their infants and young children.

HERITABILITY VERSUS THE RANGE OF REACTION

Despite the fact that Head Start deployed a kind of nursery-schooling poorly calculated to compensate children of poverty for what they failed to learn in their homes and despite the evidence of genuine gains from the improved forms of compensatory education, Arthur Jensen (1969) opened his well-known paper entitled "How Much Can We Boost IQ in Scholastic Achievement?" with this sentence: "Compensatory education has been tried and it apparently has failed." He went on to devote a major share of his paper to an explanation of the heritability of the IQ and of scholastic achievement and to the theoretical and empirical basis for the proposition that about 80% of the individual variance in intelligence, which he defined in terms of the IQ and/or Spearman's general factor, has a basis in heredity. This, he claims, explains why compensatory education "apparently has failed." He goes on to repeat the traditional explanation of class differences and race differences in terms of hereditary, biological inevitability. Parenthetically, I should add that he also suggests some modifications of educational practice with which I would agree, for for theoretical reasons quite different from his.

This paper of Jensen's had had wide circulation in influential quarters. I am told that it has been discussed at meetings of President Nixon's cabinet. Revisiting collectively the conception that 80% of the variance of intellect is an inevitable consequence of heredity could, so long as the belief prevailed, be disastrous for the enterprise and hopes of early education. The conception is often taken to imply that the effects of early education, or of education in general, must be small at best. It was the collective acceptance of this view, at least in part, that stood in the way of investigating the effects of early experience on psychological development during the 1920s and 1930s and in a way of developing a technology of early education that might have made such a project as Head Start far more successful. Thus, it is important to deal directly with this issue in any discussion of the prospects of early education.

Heritability is defined as the proportion of the total variance, within a specific population, in the measures of a phenotypic characteristic that is determined by the genetic variation within that population. The IQ and other scores from tests of intelligence or ability are such measures of a phenotypic characteristic. Correlations between measures of the IQ for pairs of relatives have been found regularly to increase with the degree of their genetic relatedness. This shows clearly that there is, indeed, an influence of heredity on the IQ. How great this influence is has been a more difficult question to answer. Various manipulations of correlations have been made in order to separate the influence of heredity from the influence of environment. Before World War II the figure of 80% for heritability got wide currency in the textbooks of psychology. It became such a dogma that the Iowa group was considered soft-headed for contending, even with data, that enrichments of experience could raise the IQs of children (see e.g., Goodenough, 1939). Shortly before he wrote his well-known paper, Jensen (1967)

devised a general formula for assessing heritability from two degrees of genetic relatedness and applied it to the correlations for all of the pairs of monozygotic (all genes in common) and dizygotic (half of the genes in common) twins in the literature. From these data, he revisits the estimate that an average heritability of .8 or 80% for scores on tests of intelligence, and he uses it in traditional fashion, as I have already noted, to explain what he calls the failure of Head Start. The argument runs this way: If 80% of the variance in measures of intelligence is a matter of heredity, only 20% can be a matter of variations in the environment. In this sense, he derives his estimate of educability from his estimate of heritability. Actually, such estimates apply only to the specific influence of the environments available on the measures for the specific population of individuals of which the indices of heritability were based. As Hirsch (1970, 1972) has pointed out repeatedly, such indices say nothing about educability or about how much the measure of any phenotypic trait might be changed through rearing under different environmental circumstances. The index of heritability is completely irrelevant to whether Head Start succeeded or failed.

Determining how much the measure of any phenotypic trait is to be modified by changes in the environmental circumstances of development calls for an entirely different investigative strategy, namely, what geneticists term the norm of reaction. First defined by Woltereck in 1909, this norm refers to the range of phenotypic reactions which a given genotype is able to produce in response to variations in the environment. Where educability is at issue, it is estimates of the range of reaction in measures of information, information-processing ability, the IQ and other test scores which should be considered. The range of reaction for measures of ability must be at least as large the difference the means averaging test scores from samples of individuals, derived from a given population, who have developed under differing environmental conditions. No general estimate of the range of reaction in the IQ, nor for the measure of any trait, is possible. Just as the generality of an index of heritability is limited to the population on which it is based, so is any given estimate of the range of reaction. Yet, let me repeat, the ultimate range of reaction for the measure of any trait must be at least as large as the difference obtained between the mean values of the measures for samples of individuals from the same population who have been reared under environmental circumstances that differ in some degree. The strategy of determining the range of reaction for the IQ in this fashion is infinitely more relevant to educability than is the percentage left over when a percentage estimate of heritability is subtracted from 100.

ILLUSTRATIVE EXAMPLES OF THE RANGE OF REACTION

Unfortunately, relatively few investigations using such a strategy for estimating the range of reaction in measures of intelligence or ability to achieve exist. A majority of these involve developmental achievements in infancy. In one such study, providing infants, beginning at 5 weeks of age, with a stabile pattern over their cribs to look at, decreased the age at which the blink response appeared, to target drops of 11.5 inches from 10.4 weeks of age for 10 control infants, reared without such opportunity to use their eyes, to an average of 7 weeks for the 10 infants provided with the stabile patterns (Greenberg, Uzgiris, & Hunt, 1968). In another such study, providing infants with visual patterns to

look at and balloons to touch decreased the age at which they achieved mature reaching for a seen target with the hand from a median of 145 days, for infants in an original normative study, to a median of 89 days for the infants in a second enrichment study where the complexity of the visual stabile was properly matched to the development of the children (White, 1967). If one casts these findings into the terms of Wilhelm Stern's (1912) IQ ratio, in order to put them into a familiar perspective, lowering the age for the appearance of the blink response from 10.4 weeks to 7 weeks constitutes a gain of approximately 48 points of the ratio. Lowering the achievement of that visual-motor coordination in mature reaching from a median of 145 days to a median of 89 days constitutes a gain in the order of 63 points of this ratio. In the terms of the IQ ratio, the range of reaction for the age of achieving the blink response must be at least 48 points, and that for the age of achieving the top level of reaching must be at least 63 points. These measures apply, of course, to only past developmental achievements. They should be taken to imply no permanence of advanced development unless the circumstances that these infants encounter are so arranged as to give them special opportunities to accommodate their advanced visual-motor skills to new situations calling for further developments.

A similar strategy can be used for indications of the range of reaction for the age of achieving object permanence. Object permanence is probably as purely cognitive as any of the achievements of the sensorimotor phase of development. Piaget has considered it to be the first basic epistemological construction. My collaborators and I have recently put together data from three studies to obtain indications of the range of reaction in the age of achieving top level object permanence. This is indicated by the infant following and retrieving a desired object which has been hidden in a container after that container has disappeared under three successive covers and come back empty. For this top level of object permanence, the infant also shows reversability in his search by going to where the container appeared last and proceeding backwards through the order of the container's disappearances. A cross-sectional study of three samples of infants, largely from working-class families, in Athens constituted one study. One sample came from the Municipal Orphanage where the infant-caretaker ratio approximates 10/1, a second sample came from Metera Baby Center where this ratio was of the order of 3/1, and the other children came largely from a day-care center for the children of working class families. At the Municipal Orphanage, the mean age for the seven children at the top level of object construction was 195.22 weeks; for those at the Metera Center, the mean was 153.51 weeks; and for the home-reared babies it was 128.86 weeks. The difference between the mean ages for the Municipal Orphanage and for the home-reared children yields a range of reaction of 66 weeks for this set of conditions.

These 66 weeks are not the total range, however, for which information is available. In Worcester, Massachusetts, Professor Uzgiris has done a longitudinal study of 12 infants from middle and upper-middle class families to test the ordinality of the landmarks in the Uzgiris-Hunt scales. The average of the ages at which these infants achieved top level of object permanence was 88.03 weeks. In the Parent and Child Center at Mt. Carmel, Illinois, 8 consecutive infants born to the parents of poverty participating in the program of this Center have also been followed with these scales in a longitudinal study for the purpose of evaluating the effects of a Mother's Training Program organized and given by Earladeen Badger.

The average age at which these infants achieved top level of object permanence was 73.02 weeks. Thus, this educational intervention served to advance the age at which the children of parents of poverty achieved object permanence some 15 weeks ahead of those reared in Worcester in middle class families. The total range of reaction for children of some parents in the lower half of the distribution of the socio-economic-educational status derives from the difference between the means for the children at the Municipal Orphanage in Athens and for the children at the Parent and Child Center in Mt. Carmel. Since a cross-sectional approach tends to exaggerate the age of achievement, a correction is required in the mean age of the children at the Municipal Orphanage. Once this correction is made, the difference yields a range of reaction of 109.3 weeks for the age of achieving object permanence. This is more than 2 years. If one casts these age-limits in the range into the terms of the IQ ratio by considering the age of the averages for home-reared children for both Athens and Worcester as the norm, the difference extends from a high of 143 for the infants at the Parent and Child Center to a low of 56 for those at the Municipal Orphanage in Athens. This transformation yields a range of reaction of 87 points in the IQ ratio for the achievement for this particular cognitive landmark under the particular variations in environmental conditions found in these three studies. It is interesting to note that these 87 points of difference between the means of the IQ ratio that constitute the obtained range of reaction differ little from the 90 points which describes the variation in individual IQs. Unless the variance in the IQ ratio for object permanence is very much larger than that for the standard IQ, the assumption that only 20% of the variance in intellectual function can derive from variations in the environment would make the chances of obtaining a range of 87 points between mean IQs infinitesimal (Hunt, Paraskevopoulos, Schickedanz & Uzgiris, 1973).

Evidence concerning range of reaction in IQ scores from standard tests at school age are coming from the Milwaukee Project under the direction of Garber and Heber (1973). This project has focused upon the infants of high-risk black mothers with full-scale WAIS IQs of less than 75 from the poorest area of Milwaukee where about 2% of the population have yielded about 33% of the children identified in school as educable mentally retarded. According to the surveys of Garber and Heber, the infants of such mothers test normally through the first year, but their test scores typically drop off thereafter until school age.

The project started with a sample of 40 such mentally retarded mothers with new infants. These were assigned randomly for either infant-stimulation or the control condition. For the 20 treated families, a home-visitor saw and played with the infant until each was approximately 6 months old. Thereafter, the infant was brought five days a week to a day-care center where each was cared for by a woman who had been selected for articulate speech and who had been trained to provide appropriate educational experiences for the infants. For the other 20 families, the program was limited to routine counseling, visits with the mothers, Gesell schedules were used from age 12 months to 21 months. Cattell and Binet tests were scheduled at three month intervals beginning at 24 months of age and at 6 month intervals beginning at 48 months of age. The differences between the means of the IQs for the treated and control groups ranged from a minimum of 23 IQ points at age 24 months to 34 IQ points at age 66 months. Thus, at school age, the IQs of the treated group average 125 while those of the control group average 91.

This average for the control is a whole standard deviation above that of their mothers who were selected to have IQs under 75. This increase for the controls is itself unusual, and probably derives in part from the repeated testing as well as from the expected regression effect. Inasmuch as the children from such mothers in the original survey of Garber and Heber had average IQs of the order of 78. Thus, unless there is something very wrong with this demonstration that I cannot now see, it provides evidence of a range of reaction of at least 45 points in the IQ average for children of school age from black mothers selected from those of the highest risk.

Another example is to be found in the cross-cultural study by Dennis (1966). Dennis got mean IQs from giving the Goodenough Draw-A-Man test to samples of healthy children, aged between 6 and 9 years, who were living in typical family environments in some 50 cultures over the world. The variation in the mean IQs for these samples ranged from a high of 124 to a low of 52. Mean IQs of 124 came from samples of suburban children in America and England, from a sample of poor children growing up in a Japanese fishing viallage, and from a sample of Hopi Indian children. The low mean IQ of 52 came from a sample of children in a nomadic Beudouin tribe of Syria and another IQ of 53 came from children growing up in a nomadic tribe in the Sudan. In the four cultures with the highest mean IQ, the children grew up in almost continuous contact with representative, graphic art that was important in their everyday living. On the other hand, the cultures with the lowest mean IQs were not only nomadic in character, but they embraced the Moslem religion. This religion has always been more effective in prohibiting contact with graphic art than either Judaism or Christianity. Since this was a cross-cultural study, these samples of children cannot be said to have come from the same population. Yet, even among groups of Arab Moslem children, the mean IQs from the Draw-A-Man test range from a low of 52 for the Ayrian Bedouins to a high of 94 for the children of Lebanese, Arabs in Beirut who see television and have considerable contact outside their homes with the graphic art in western civilization. There the range of reaction for the Draw-A-Man IQ is 72 points which is only 18 points short of the variation in individual IQs from standard tests. This Draw-A-Man test probably calls for a considerably less complex set of abilities, as these are assessed by factor analysis, than either of the more standard scales. Yet, for American children, IQs from the Draw-A-Man test correspond about as well with IQs of either the Stanford Binet test or the Wechsler Bellevue Children's Scale as IQs from these two more standard scales correspond with each other.

I have contended on logical grounds that indices of heritability say nothing about educability. Evidences of educability must come from the investigative strategy that I have used for assessing the range of reaction. As I have said, there can be no general range of reaction. Yet, if environmental conditions could produce no more than 20% of the variance in cognitive achievements and intelligence, then the changes of obtaining such ranges as I have reported here would be infinitesimal. Despite the fact that heredity undoubtedly makes a substantial contribution to individual differences in competence, such findings as I have synopsized here appear to imply that all but a very small fraction of human beings have the hereditary potential to achieve the various competencies required for full participation in our culture despite its advanced technology. It is highly important that those in the position to control the support for research and for the development of educational technology recognize this fact.

TOWARD AN EDUCATIONAL TECHNOLOGY OF INFANCY AND EARLY CHILDHOOD

If the financial support is forthcoming, we should get on with our investigations of early psychological development and with improving the technology of early education -- and of later education as well. The task is tremendous and I fear we must clear away some of the conceptual and methodological blind alleys of the past in order to get on with it. I believe we must cease to look upon development as "intrinsic growth," to use one of Gesell's favorite terms, and see it in terms of continuous, on-going adaptive interaction of the infants and children with their environmental circumstances. I believe we must cease to think of development in terms of powers that increase with age and think of it instead as an epigenetic process of achieving a series of organizational structures built one upon another, in the course of adaptive infant-environment interaction. Recognizing the epigenetic, hierarchical nature of behavioral development calls for a major change in our methodology of assessment and measurement. It calls also for relinquishing the traditional concept of maturational readiness in favor of the notion that I like to call "the problem of the match." I believe we must also change our conception of motivation in development and acknowledge a much larger place than we have heretofore for that motivation which is inherent in information processing and action. Only after we have made such conceptual and methodological changes will we do the kind of investigation that will lead directly to improvements in our technology and early education and child-rearing. Let me indicate in at least synoptic fashion what I mean by each of these statements.

First, about seeing development in terms of adaptive infant-environment interaction instead of intrinsic growth. As one holds an infant and observes his apparent effort to stand up, it is easy to see the reason for Gesell's notion of "intrinsic growth." Those who have seen his film entitled, "Life Begins," will recall that such behavior in a baby being bathed is the scene which inspires one of Gesell's homilies on intrinsic growth. On the other hand, in that Athenian Orphanage where there are ten babies per caretaker or in a similar orphanage in Tehran, the children developing from birth under these conditions seldom sit up during their first year of life. In 1957, when Dennis visited in Tehran the forerunner of the orphanage where my investigation is now underway, two-thirds of those infants in their second year were still not sitting up, and approximately 80% of those in their fourth year were not yet walking (Dennis, 1960). In a study of human enrichment, the one thing that changed greatly were these forerunners of locomotion. All but one of the ten infants in the group constituting this wave were standing and cruising around about their cribs at the end of the first year. For this part of the investigation, the caretakers and student nurses were permitted to do what came naturally. They carried the babies about. This carrying enabled the infants to use adaptively and develop their balancing equipment and strengthen their legs. Similarly, infants who have developed from birth under the conditions of these orphanages have almost no language at three years of age. If one considers such observations along with the evidences of the range of reaction in the age of achieving various functions during infancy, Gesell's concept of intrinsic growth becomes quite untenable. Unfortunately, so long as one believes that growth comes automatically with time from the influence of the genes, he tends to be blind to such evidences that the rate of development is very largely a function of adaptive infant-environment interaction.

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Second, psychological development as an epigenesis of organizational structures rather than a predetermined growth of intellectual power. Spearman's (1904) tetrad-difference method of treating the intercorrelations among test scores provided in his general factor (g) the statistical underpinnings for the notion of a unitary intellectual power or dimension of mind. Spearman even thought of his g-factor as mental energy which increased as a child grew. Later, when it was found that scores based on testings during infancy failed to predict scores from tests given later, John Anderson (1940) reasoned that this lack of predictive capacity for the infant tests might derive from the fact that their behavioral content was very dissimilar from the behavioral content of the later tests. This dissimilarity of behavioral content across ages is inevitable from the epigenetic character of early behavioral development. It has been the merit of Jean Piaget (1936, 1937) to make this epigenesis clear from his observations of the development of his own three children. It was Piaget's observations that inspired the ordinal scales of which object permanence is one (Uzgiris & Hunt, 1974). Although I have doubts about Piaget's six sensorimotor stages, I believe I see evidence of a great many learning sets in the behavioral transitions of psychological development in infancy and early childhood. One of the earliest of these is the set that things should be perceptually recognizable. It appears to account for that transition between looking longer at a pattern familiar than unfamiliar in a pair to looking longer at the pattern unfamiliar than familiar in a pair (Greenberg, Uzgiris, & Hunt, 1970). Another appears to account for the gradual generalization of initiative that comes with repeatedly obtaining perceptual feedback from self-initiated actions in a variety of situations. It is as if the infant were learning he can act to make interesting things happen by his own actions. Yet another that has been known for a long time appears to account for infants asking "What's that?" The fact that such requests persist till the object is named suggests that the learning set is a generalization that "things have names." These learning sets take many forms. We're only beginning to understand them, but I suspect that discovering their nature and the nature of the interactions which foster them will lead directly to improvements in the technology of early education.

Third, consider the change that is needed in the methodology of assessing psychological development. Although Binet and Simon began their studies that lead to tests of intelligence in order to improve the educational technology for the children of Paris, their metric of mental age, and that of the IQ suggested by Wilhelm Stern (1912) both contributed a disservice to the investigation of psychological development and to improvement in educational technology. The very existence of these metrics helped to foster the idea of a unitary power and to distract observers from seeing the transitions between successive organizational structures and the environmental conditions for which these transitions were adaptive. Moreover, in making age the chief independent variable, these metrics of MA and IQ tended to hide the role of environmental conditions in behavioral development. Finally, the IQ did a special disservice to education by offering a ready explanation for teacher failures. Once a child was labelled with a low IQ, when he failed to learn, he was doing "as well as could be expected." The findings of Rosenthal and Jacobsen (1968) have recently dramatized this relationship under the title of "Pygmalion in the Classroom."

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Two alternative methodological strategies are promising. One consists of ordinal scales. In these, the landmarks of behavioral transition are arranged in the sequence in which they appear. Such scales focus attention on the nature of the behavioral transitions. Moreover, when individual differences are stated in terms of age of achieving these transitions, age becomes a dependent variable rather than a cause, and attention can focus on the nature of the circumstances which produce differing ages of achievement. A second alternative exists in the criterion-referenced tests suggested for instructional research by Robert Glaser (1963). Norm-referenced tests get their meaning from comparing the performance of a child with that of the normative group. The process of quantification distracts the attention for what is being learned. Referencing the criterion, on the other hand, focuses the attention of both child and teacher directly on the goal of the learning process and tells them when each specific learning job is done.

Fourth, the matter of readiness. Traditionally, readiness has been seen as a product of that intrinsic growth that comes automatically through genetically predetermined maturation. Such a view dictated the practice of sending children home to await the maturity required for success in school. Once development is seen as a product of adaptive child-environment interaction, such a conception of readiness is untenable. Instead, readiness becomes a matter of having already achieved the learning sets, the information processes, the information, the motivational systems required for educational profit from encountering the curriculum of the school. Whether or not encountering any situation will foster development is a matter of the organizational structures that the child brings ready-made to the situation. This is what I call "the problem of the match."

Fifth, that form of information inherent in information-processing and action provides at least a provisional solution to the problem of the match. Newborn infants come equipped with the orienting response to changes in on-going input. A few repeated encounters with the same objects, places and persons leads to their recognition, and to extinction of the orienting response. At first the recognitive familiarity is attractive. Later it is the novel pattern which attracts attention and evokes scrutiny. But it is an optimum of novelty and an optimum of challenge that interests an infant or child. Things and operations repeatedly encountered become boring. Those calling for an adaptive modification beyond reach become threatening. Thus, for those who attempt to guide the learning of the young, it is the behavioral signs of interest that are most helpful in solving the problem of the match. Inherent in such intrinsic motivation is, I believe, the incentive for a continuing development of more and more complex organizational systems and skills. Keeping children in situations that remain essentially constant produces both boredom and failure to develop. On the other hand, making approval and love contingent upon the child's achieving the adaptive modification beyond his reach can do real damage. This is the nature of pushing children. On the other hand, if an infant is free to accept or leave the situational challenges prepared for him, no damage can be done. As children get older, they also profit from being shown by those older and more knowledgeable how to cope with challenges that stretch their accommodative capacities.

Such is the conceptual background for the Mother's Training Program of Earladeen Badger (1971a, 1971b, 1971c). In this program, mothers and teachers are encouraged strongly to believe that how they interact with their babies will make an important difference in their future development. Second, while the babies are very young, they are encouraged to be responsive to their vocal behavior and to their behavioral indicators of distress. Third, they are taught to observe carefully their infants as they interact with imitative models and play materials and to note the behavioral indications of interest, of boredom, and of the distressful frustration that comes with situations that over-match the infant's accommodative capacities. Fourth, the mothers and caretakers are encouraged to provide their infants with materials and models that evoke the behavioral signs of interest and to remove those that appear to be either boring or threatening. Finally, they are shown enough about the sequences of developing abilities and interest to help them choose materials that will interest their infant shortly on the basis of what interests them now. The fact that the eight infants from families of poverty at the Parent and Child Center in Mt. Carmel, Illinois, achieved the top level of object permanence at an average of some 15 weeks earlier than did the 12 infants from middle-class families of Worcester, Massachusetts, suggests strongly that this program of mother training is on the right track.

Much, however, remains to be learned. The ordinal scales of Uzgiris and Hunt (1974) extend only through the sensorimotor phase. Such scales remain undeveloped for the phase between the sensorimotor and that of concrete operations, in the language of Piaget (1947). This is the period in which children achieve more complex motivational systems, elaborate their interactions with objects, persons, and places, and acquire the vocal signs with which to communicate about what they have experienced and what they do. To guide learning during the preconceptual phase, to use Piaget's term for it, we need a much more detalied account of the nature of the behavioral transitions that occur and of the nature of the situations which foster them. Piaget's (1945) observations of this phase of development have lacked the necessary specificity to guide the development of ordinal scales. On the other hand, such observations of linguistic development as those of Roger Brown (1973) and his collaborators are highly useful, but even they leave much to be learned.

Lacking ordinal scales for this preconceptual phase, Girvin Kirk and I have developed a series of criterion-referenced tests of semantic mastery and school readiness. These serve well to define certain of the deficiencies in children of the poor and to direct the nature of some of the matters that should be included in compensatory education (Hunt & Kirk, 1973). For instance, where roughly from 60 to 90% of children from middle-class families can name colors, positions, and shapes and respond appropriately to terms for them, only from 5 to 20% of the children of poverty in a Head Start program show such semantic mastery.

Although we have a long way to go before we could state with any confidence how much could be achieved by mounting a universal program such as Head Start, if support continues for the necessary research and development in the technology of early education, we shall be able to do much better than we ever have done. A program of Home Start would probably accomplish more than can ever be done with

compensatory education. Many parents of low socio-economic and educational status can be taught to be quite effective teachers of their infants and very young children. Getting them involved in the educational aspects of child-rearing while their children are infants and until they enter school is likely to make them much more concerned and more sophisticated about what their children are doing in school. On the other hand, the work of Garber and Heber (1973) suggests that there may well be a small portion of parents who will need the help of educational day-care outside the home if their children are to have anything approaching equality of opportunity. We need also to investigate the sociological aspects of obtaining the cooperation of parents for such new institutions as the Parent and Child Centers

CHANGES FOR THE PUBLIC SCHOOLS

As a student of infancy and early childhood education, the programs of the public school fall outside the limits of any expertness that I may claim. Yet, I believe I see need for certain changes. First, inasmuch as children come to school at ages 5 or 6 with very large variations in experience with objects, places, and persons, and very large differences in semantic mastery, much more should be done to individualize instruction. Teacher-centered classrooms should probably give way to what is being called open schools where each child has his own task. In order to individualize instruction, however, I believe we shall have to develop criterion-referenced tests with which to diagnose what needs to be learned and to define when a given job of learning is done. In his recent book on Inequality, Christopher Jencks (1972) presents evidence indicating that schools as they now exist do a relatively poor job of socializing and teaching the young. Instead, they serve chiefly a certifying function. Most of the real learning goes on in the home and in life outside the school. In considerable degree, I suspect that Jencks is correct, and I suspect that he is correct because the use of standardized, norm-referenced tests has disengaged testing from teaching. As a consequence, children bringing highly different ready-made abilities and interests are submitted to curricula, and then examined by tests on which their performances get meaning in percentile ranks or educational age from being compared with those of other children. Instead of defining the goal of learning tasks and indicating when each goal has been achieved, such comparative procedures threaten the self-respect of many, and distract both the teachers and pupils from the learning job at hand. If schools would define their criteria or each learning task, and if they had children persist until these criteria were achieved, they would serve the teaching function rather than a mere certifying function.

Schools also fall short of doing what they need to do in part, I believe, because they have not changed their mode of operation to match the changes that have taken place in our culture. From about age 10 on through high school, most of the youth of today have experiences which differ radically from those of my generation who grew up before and during World War I. My generation was information poor, except for those relatively few growing up in well-to-do, educated families. On the other hand, we had a great deal of experience in undertaking and completing tasks that made a difference in our everyday lives. Models of the workaday world were seen every day. Moreover, growing up in the North Platte valley of Western Nebraska, I saw first hand what the technology of irrigation could do for the

productivity of a desert. With the emergence of the radio and television, this relationship has reversed. Today, as James Coleman has beaten me to pointing out, our culture is rich in information for the young, but all to few of them come directly in contact with models of the workaday world or get experiences undertaking and completing tasks that make a difference in their lives and in the lives of their families. I would like to suggest seriously that the time in school devoted to traditional academic skills and information be halved, and that the schools guide the young in chosing and undertaking tasks that need to be done for the good of the community, and then help them direct themselves in the completion of these tasks. I suspect that more would be learned about participation in and about making our society work than could possibly be learned from merely absorbing more information.

IN CONCLUSION

Our culture faces serious problems, indeed; but these problems make great opportunities if we meet the challenge and cope with them. I am confident that we shall not meet the challenge by turning our back upon science and technology. Some weeks ago I read of a scientific technical innovation concerned with both environmental pollution and the energy crisis out of which I got a kick. Two biochemists in Israel were disgusted by the bogs of black petroleum polluting their beaches. Wherever petroleum is being hauled in tankers or super-tankers, such pollution has been inevitable. It is no mere matter of accidental spills. Most of this pollution comes from the routine operation of flushing out the water used for ballast for the trip back where the tanker can take on a new load of crude oil. Each year, the world's tankers dump approximately a million tons of oil into the oceans. These Israeli biochemists, Gutnick and Rosenberg, isolated a genus of bacteria which feasts on crude oil, and then they developed a particularly fast-multiplying strain. They put a flash of their fast-multiplying strain of oil eating bacterial into a tanker that had just taken on it ballast of sea water for the return trip after unloading its crude oil. Into the tanker of sea water they also put some urea and potassium phosphate and arranged to bubble air into the mixture through a perforated hose. About a week later when the tanker had reached its destination and was ready to take on another load of crude oil, the bacteria had gobbled up the black, waxy parafin of the crude oil that usually goes into the sea, left about 200 tons of dewaxed oil ontop that could readily be made into gasoline, and produced about 150 tons of high-quality protein that can ultimately be processed for animal food. The tanker was clean, and, since these bacteria conveniently die when they run out of crude oil, they do no harm to other life in the ocean. A few of such technological applications of science directed to the challenges of our day can rapidly swing the pendulum of opinion in the direction of approval for both science and technology and in the direction of optimism.

Such applications convince me that the challenges of today lead to more technology rather than less for our culture in the future. The importance of ability to process information symbolically in language and numbers will increase for employment and for participation in the culture. The fact that plasticity in psychological development is greatest during infancy and early childhood guarantees,

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in the long run, an important place for early education in the adaptive evolution of our society. Early education can also help a major share of those under the power of others to achieve the power to control their own lives in a democratic community. Although many problems in the domain of early psychological development remain unsolved, we can solve them, if we get the support to do the necessary research, and we can improve the technology of education for infants and young children enough to enable all but a very few to take a productive place in our increasingly technological culture.

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